10/527204
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Highly dynamic valve servocontrol device

The invention relates to a highly dynamic valve servocontrol device with a bushing having control edges and contained in a main body and a slide valve having control edges contained in the main body, wherein at least one of the slide valve control edges can slide with respect to a control edge on the bushing.

Highly dynamic valve servocontrol devices are known from the state of the art. These valve servocontrol devices are used in the state of the art to control, in either open or closed loops, volume flows and / or pressures in hydraulic systems. To change volume flows, control cross-sections are changed through a movement of control edges, possibly on a slide valve and with the aid of a direct or indirect drive.

Directly controlled valves comprise electromechanical transformers, proportional magnets, linear motors, plunger coils or piezoelectric converters. Servo-assisted valves are indirectly driven drives, such as for example, mechanical-hydraulic transformers, spool valves, nozzle baffles and nozzle pipes. Highly dynamic valve servocontrol devices comprise both direct as well as servo-assisted valves.

Previously, only one position of the slide valve or the bushing was varied and consequently also direct control cross-sections of the valve servocontrol device. These control cross-sections are here bounded by two control edges, whereby the state of the art includes an active, i.e. changing in its position, control edge, possibly on the slide valve, and a passive, i.e. fixed control edge, possibly on the bushing. The attainable frequency of the valve servocontrol device is in the existing cases provided by a slide valve drive and an associated drive or control electronic unit.

Directly controlled valve servocontrol devices have however the disadvantage that fast reactions can only be realised with short-stroke valves.

It is therefore the object of this invention to facilitate the highly dynamic control of the valve servocontrol device.

This is achieved in that the slide valve and also the bushing are embodied such that they are oppositely slidable to one another and can be moved relative to the main body 2.

The distances to be covered by the slide valve or bushing during a control movement are therefore clearly smaller. The times taken from one control state to the next are shorter. Highly dynamic control of the valve servocontrol device is therefore possible. Also, existing freely obtainable standard components can be used in a valve servocontrol device according to the invention. This simplifies the procurement of the individual elements for assembly.

Special implementation variants are described in more detail in the subclaims.

It is especially advantageous if the valve servocontrol device comprises a device determining the bushing position relative to a position of the slide valve. In this type of embodiment it is possible to determine the exact position of the slide valve with respect to the bushing and to actuate the valve servocontrol device accordingly.

Also in a further variant it is especially advantageous if the bushing position determining device comprises an eddy current sensor. A non-contacting eddy current sensor operates without wear and is rugged. Also it is extremely resistant to corrosion, whereby the service life of the valve servocontrol device is increased.

If, in a variant, the valve servocontrol device exhibits an absolute position determining device for determining the position of the bushing and slide valve with respect to the main body, then the exact position of the bushing and slide valve to the main body can be found advantageously in this variant. This facilitates the avoidance of drift of the bushing and slide valve in the main body. Consequently, trouble-free functioning of the valve servocontrol device is enabled also over a lengthy period of use. An absolute measurement is only necessary if the slide valve and bushing are servo-assisted.

In a constructional variant it is also especially advantageous if the bushing position determining device or the absolute position determining device comprises an eddy current sensor, a Hall effect sensor or an inductive displacement transducer (LVDT). Since possibly the exploitation of the property that a movement of electrons in the magnetic field is influenced and a thereby ensuing deflection can be acquired as a voltage on the Hall effect sensor, this has the advantage that very large magnetic fields can be measured and the measurement range of Hall effect sensors is noticeably larger than those of other sensors. The use of known measurement sensors in the bushing position determining device or in the absolute position determining device is especially advantageous in this variant, because costs and effort in the procurement of the appropriate sensors can be avoided.
If the valve servocontrol device comprises a primary drive device and / or a high frequency drive device, then in this variant it is advantageous if both the bushing and the slide valve are movable. Also, it is possible to combine the two different drive device principles, primary drive device and high frequency drive device.

If in one variant the primary drive device comprises at least one pilot valve influencing the movement of the bushing or the slide valve, then the application of a wear-free and rugged standard component is advantageously taken up.

In another embodiment it is especially advantageous if the valve servocontrol device comprises at least one pilot valve controlling the movement of the bushing and a pilot valve controlling the movement of the

slide valve. Rugged and particularly small and compact elements are then used for the slide valve and the bushing on the drive side.

In one variant it is also advantageous if the valve servocontrol device at least comprises a high frequency drive device. A high frequency drive device has the significant advantage that it has very short response times.

If the high frequency drive device comprises a piezoelement or a plunger coil, small dimensions of the high frequency drive devices are possible. Small installation spaces are desirable.

It is also advantageous in a variant if the high frequency drive device controls at least a displacement of the bushing. Consequently, the response time of the bushing is minimised during the control.

In a further embodiment it is advantageous if the high frequency drive device exhibits a high inherent dynamic response and a low stroke and the primary drive device exhibits a low inherent dynamic response and a large stroke. Since the high frequency drive device effectively complements the primary drive device in terms of inherent dynamic response and servo gain, particularly fast control times are possible. The combination of a highly dynamic response / short stroke and medium (low) dynamic response / long stroke leads to high servo gain.

If the high frequency drive device exhibits a low inherent dynamic response and a large stroke, and the primary drive device exhibits a high inherent dynamic response and a low stroke, then in another variant an exchange of high frequency drive device elements with primary drive device elements is possible. The advantage of a particularly fast control of the individual components of the valve servocontrol device is however ensured.

In the following, embodiments of this invention are explained in more detail based on a drawing. The following are shown:

Figure 1: The cross-section through a highly dynamic valve servocontrol device.

In Figure 1 the valve servocontrol device 1 is shown in a cross-section. The valve servocontrol device 1 comprises a main body 2 in which a bushing 3 is supported. The bushing 3 exhibits control edges 5. The control edges 5 are formed in the interior of the bushing 3. In the interior of the bushing 3 a slide valve 4 with control edges 5 formed on the circumference is formed for movement within the bushing 3.

Through openings pass through the bushing 3. The through openings 14 are connected with through openings 14 in the main body 2.

The bushing 3 is constructed for movement using a high frequency drive device 11 in this embodiment. The high frequency drive device 11 slides the bushing 3 in one direction. The high frequency drive device 11 comprises the piezoelement 13. The piezoelement 13 has the advantage of a very fast response and pushes the bushing 3 in one direction. A return movement is provided by a spring 20.

In this embodiment the slide valve 4 is moved either in one direction or the other by fluids under pressure. The fluids are transported through pilot valves 12 to one side or the other of the slide valve 4 by a primary drive device 10. The pilot valves 12 are supplied via the primary drive device 10, which exhibits feed channels for providing the fluid to the pilot valves 12, with preferably an incompressible fluid. The feed channels are connected to the pilot valves. Alternatively or in support, the use of the spring 20 can be considered.

The position of the slide valve 4 in the bushing 3 is determined by an eddy current sensor 7 embedded in the bushing 3, the said sensor forming part of a bushing position determining device 6.

An absolute position determining device 8 is also embedded in the housing 2. The absolute position determining device 8 is in this embodiment a Hall effect sensor 9. The Hall effect sensor 9 is located therefore between the housing 2 and the bushing 3. The exact positions of the bushing 3 and the slide valve 4 with respect to the housing 2 and to one another are determined by the position determination using the bushing position determining device 6 and the absolute position determining device 8. In other embodiments the bushing position determining device 6 and the absolute position determining device 8 comprise other sensors known from the state of the art.

In another variant the primary drive device 10 and the high frequency drive device 11 also use standard known elements from the state of the art.

Alternatively, the movement of the bushing 3 can be advantageously achieved by a transfer of force through a transfer medium, such as an incompressible fluid such as oil, whereby the movement of the slide valve 4 is also achieved via a transfer medium, such as an incompressible fluid such as oil. The two transfer media can be controlled separately from one another. The possibility of a predefined forced coupling between the two transfer media can also be used here.

The slide valve can be formed for movement solely through the effect of the transfer medium in both directions. However, it is also possible to provide other movement devices at one end, which, for example, derive their energy from a spring force for moving the slide valve and / or bushing.

Art 19 Amdt.

5

10/527204

DT06 Rec'd PCT/PTO 10 MAR 2005

MODIFIED CLAIMS

[Arrived at the International Office on 9th December 2003 (09.12.03); original Claims 1-13 replaced by new Claims 1-10 (2 pages)]

1. Highly dynamic valve servocontrol device (1) with a bushing (3) exhibiting control edges and contained in a main body (2), and a slide valve (4) exhibiting control edges and contained in the main body (2), wherein at least one of the control edges (5) of the slide valve (4) can slide with respect to a control edge (5) of the bushing (3), wherein the slide valve (4) and also the bushing (3) are embodied such that they are oppositely slidable to one another and can be moved relative to the main body (2), wherein the valve servocontrol device (1) comprises a primary drive device (10) and / or a high frequency drive device (14), wherein the primary drive device (10) comprises at least one pilot valve (12) which can influence the movement of the bushing (3) or slide valve (4), **characterised in that** the high frequency drive device (11) comprises a piezoelement (13) or a plunger coil.

2. Highly dynamic valve servocontrol device (1) according to Claim 1, **characterised in that** the valve servocontrol device (1) comprises a bushing position determining device (6) for determining a position of the bushing (3) in relation to a position of the slide valve (4).

3. Highly dynamic valve servocontrol device (1) according to Claim 1 or 2, **characterised in that** the bushing position determining device (6) comprises an eddy current sensor (7).

4. Highly dynamic valve servocontrol device (1) according to one of the Claims 1 to 3, **characterised in that** the valve servocontrol device (1) exhibits an absolute position determining device (8) for the determination of the position of the bushing (3) and slide valve (4) in relation to the main body (2).

5. Highly dynamic valve servocontrol device (1) according to one of the Claims 1 to 4, **characterised in that** the bushing position determining device (6) or the absolute position determining device (8) comprises an eddy current sensor, a Hall effect sensor (9) or an inductive displacement transducer (LVDT).

MODIFIED PAGE (ARTICLE 19)

6. Highly dynamic valve servocontrol device (1) according to one of the Claims 1 to 5, **characterised in that** the valve servocontrol device (1) comprises at least one pilot valve (12) controlling the movement of the bushing (3) and a pilot valve (12) controlling the movement of the slide valve (4).

7. Highly dynamic valve servocontrol device (1) according to one of the Claims 1 to 6, **characterised in that** the valve servocontrol device (1) comprises at least one high frequency drive device (11).

8. Highly dynamic valve servocontrol device (1) according to one of the Claims 1 to 7, **characterised in that** the high frequency drive device (11) controls at least one movement of the bushing (3).

9. Highly dynamic valve servocontrol device (1) according to one of the Claims 1 to 8, **characterised in that** the high frequency drive device (11) exhibits a high inherent dynamic response and a low stroke, and that the primary drive device (10) exhibits a low inherent dynamic response and a large stroke.

10. Highly dynamic valve servocontrol device (1) according to one of the Claims 1 to 9, **characterised in that** the high frequency drive device (11) exhibits a low inherent dynamic response and a large stroke, and that the primary drive device (10) exhibits a high inherent dynamic response and a low stroke.

MODIFIED PAGE (ARTICLE 19)